

**CALTEMP: A BASIN-SCALE MODEL FOR
SIMULATING WATER TEMPERATURE, FLOW
AND SCALAR TRANSPORT IN
SACRAMENTO VALLEY RESERVOIRS,
RIVERS, AND STREAMS**

Geoffrey Schladow

Public Comments

No public comments were received for this proposal.

Technical Synthesis Panel Review

Proposal Title

#0142: CALTEMP: A BASIN–SCALE MODEL FOR SIMULATING WATER TEMPERATURE, FLOW AND SCALAR TRANSPORT IN SACRAMENTO VALLEY RESERVOIRS, RIVERS, AND STREAMS

Final Panel Rating
adequate

Technical Synthesis Panel (Primary) Review

TSP Primary Reviewer's Evaluation Summary And Rating:

The project will develop, calibrate and validate a predictive, unsteady flow, temperature and scalar transport model of the principal streams in the Sacramento, Feather and American river systems and in associated reservoirs. To do so will require linking several models and to collect considerable amounts of field data. While a useful exercise, it is very expensive with only incremental value. Other possible approaches are not evaluated. Most importantly, the relevance of such detailed temperature data to the fish in the system is not demonstrated.

Additional Comments:

The introduction provides a description of the linkages between flow, temperature, and some aspects of fish biology/ecology. Unfortunately, how changes in water temperature will effect long-term smolt production is quite uncertain. Hence, doing a better job of modeling water temperature changes is not going to improve significantly salmon populations or the assessment of the benefits of various CALFED flow restoration efforts. Hence, the statement that "the output of the proposed model is precisely what is

Technical Synthesis Panel Review

required for fish population dynamics modeling", is a gross over-simplification. Little detail on the stream water temperature model is provided in the proposal even though this is the critical component of the entire exercise. There seems to be circularity in the use of temperature data to calibrate the unsteady flow model. The monitoring component of this application is based on installing roughly 1000 temperature loggers throughout the Sacramento system, but there is little detail about the monitoring design: duration, time-step of data logger, site selection or quality control. The applicants have not provided an indication as to how critical each of the individual components are to the overall goal of providing a 'complete' regional model of the Sacramento River system. For example, if the data on one of the tributaries or reservoirs proves problematic, what is the impact of this on the model results?

The project will develop, calibrate and validate a predictive, unsteady flow, temperature and scalar transport model of the principal streams in the Sacramento, Feather and American river systems and in associated reservoirs. To do so will require linking several models and to collect considerable amounts of field data. While a useful exercise, it is very expensive with only incremental value. Other possible approaches are not evaluated. Most importantly, the relevance of such detailed temperature data to the fish in the system is not demonstrated.

Technical Synthesis Panel (Discussion) Review

TSP Observations, Findings And Recommendations:

The applicants propose a set of sophisticated physical models of temperature in surface water. They fail to make the case that such sophisticated models are necessary to understand the ecological response of fishes and other organisms. Also, the linkage to future climate scenarios is not well-documented. The adequate rating reflects the technical skill of the team and their proposal to use appropriate physical models.

Technical Review #1

proposal title: CALTEMP: A BASIN–SCALE MODEL FOR SIMULATING WATER TEMPERATURE, FLOW AND SCALAR TRANSPORT IN SACRAMENTO VALLEY RESERVOIRS, RIVERS, AND STREAMS

Review Form

Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	<p>This proposal is well written. The introduction provides a good description of the linkages between flow, temperature, and some aspects of fish biology/ecology. Unfortunately, we are quite uncertain about how changes in water temperature will effect long-term smolt production, which is the key variable of interest to CALFED. Table 2 of the proposal provides the standard preferred temperature ranges. We are very uncertain about the population-scale effects of deviating from these ranges. Doing a better job of modeling water temperature changes is therefore not going to help improve salmon populations or assess the benefits of various CALFED flow restoration efforts. The weak linkage in the chain is the relationship between temperature and smolt production (via effects on pre-spawn mortality, incubation success, rearing, etc..). Until these relationships are established in the field through well-designed adaptive management experiments coupled with very good stock assessment monitoring, doing a better job at predicting water temperatures, or how they will change with future climate, will not be very useful.</p>
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Technical Review #1

Rating	fair
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Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full-scale implementation project justified?

Comments	If CALFED wants predictions of water temperatures on a basin/regional-scale this seems like a worthwhile and well thought-out effort. However I feel the project is not well justified because 'temperature-related' CALFED money would be better spent on reducing uncertainty in the fish population response -temperature linkage.
Rating	fair

Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	Unfortunately, very little detail on the stream water temperature model is provided in the proposal even though this is the critical component of the entire exercise. I assume the model generates reach-average (between node) water temperatures at a relatively short timestep (e.g. 1 hr or less). I am assuming the model does not simulate variation in temperature along the cross-section (e.g., predict higher inshore water temperatures which would influence juveniles) or other aspects of spatial variation. In particular, I am assuming the model will not predict local cool-water refugia at tributary confluences or groundwater sources. Describing this spatial variation may be more
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Technical Review #1

	<p>important than getting the reach-average temperatures correct. By trying to model a huge area the proponents have had to give up on getting into such details, which may be a real shortcoming.</p> <p>There seems to be a bit of a circularity in the use of temperature data to calibrate the unsteady flow model. (1st paragraph, p. 8). As I understand it, the unsteady flow model will predict water travel times which will in turn influence the extent of warming or cooling as water moves downstream. Water temperature data can be used to calibrate the temperature model, or can be used to calibrate the unsteady flow model, but I don't think it can be used to calibrate both. This is a relatively minor point but if correct it suggests that more stage sensors are required to provide an independent calibration of the flow model.</p> <p>The approach for translating predicted changes in water temperatures under different management regimes or due to climate change into fisheries impacts is very crude. The proponents have made an effort to at least list/discuss the temperature-fisheries issues in their proposal. What they don't do is highlight how uncertain we are about the population effects of deviations from the preferred ranges. I disagree strongly with the statemet on p. 15 re. scientific justification that: "the output of the proposed model is precisely what is required for fish population dynamics modeling". The assumption here is that we can translate predicted water temperature changes into meaningful biological metrics such as growth, reproduction, and survival. We can't, and no work is proposed in this study to address this uncertainty. This is pretty much a fatal flaw.</p>
Rating	fair

Technical Review #1

Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	The proponents seem very competent and write a very clear proposal. The plan looks good. What they propose to accomplish seems feasible.
Rating	very good

Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	The proposed extensive temp. monitoring network is critical for calibration and will probably be a useful long term dataset for other efforts. As stated in my comments on the approach, I think giving up on studying small-scale variation in temperature variation could be a short-coming.
Rating	good

Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	If CALFED plans to manage flow and fish populations based on predicted temporal and spatial water temperature distributions, the products from this work have high utility.
Rating	good

Technical Review #1

Additional Comments

Comments

Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	Based on the quality of the writing and ideas in the proposal the proponents seem highly qualified for the work.
Rating	excellent

Budget

Is the budget reasonable and adequate for the work proposed?

Comments	The budget is large, but so is the scale of them modelling effort. In this sense I have no problems with the budget. In a larger context, I feel the 'temperature' related CALFED efforts should be focused on fish population/parameter issues, not providing better/regional temperature predictions.
Rating	good

Overall

Provide a brief explanation of your summary rating.

Comments	If CALFED wants a regional-scale water temperature model than this seems like a good project and worth funding. In general I feel too much effort in CALFED is spent on physical modelling exercises. The major uncertainties lie in fish population responses to flow/temperature changes, not in our ability to predict temperature and or flow. Based on this perspective I do not think this is a good use of
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Technical Review #1

	CALFED funds, and provide only a FAIR ranking.
Rating	fair

Technical Review #2

proposal title: CALTEMP: A BASIN–SCALE MODEL FOR SIMULATING WATER TEMPERATURE, FLOW AND SCALAR TRANSPORT IN SACRAMENTO VALLEY RESERVOIRS, RIVERS, AND STREAMS

Review Form

Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	<p>ARE THE GOALS, OBJECTIVES AND HYPOTHESES CLEARLY STATED AND INTERNALLY CONSISTENT? Yes, the goals and objectives are internally consistent. There are no obvious hypotheses put forth in this proposal that the applicants seem to be testing. This is not necessarily a criticism as much as an observation. The premise seems to be instead that water temperatures in the face of future climate change are important to ecosystems and fish, and the proposal then seeks to provide that information through some modelling. I don't see the value in forcing an applicant to morph their proposal into a few explicit hypotheses.</p> <p>IS THE IDEA TIMELY AND IMPORTANT? Yes, if you accept the applicants' premise, which is well supported by the literature, their idea is extremely timely and topical.</p>
Rating	very good

Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full–scale implementation project justified?

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Technical Review #2

Comments	<p>IS THE STUDY JUSTIFIED RELATIVE TO EXISTING KNOWLEDGE? Yes. The applicants highlight a lack of data or studies on both climate change and water temperatures in the Bay-Delta system. Within that context, this study is very topical.</p> <p>IS A CONCEPTUAL MODEL CLEARLY STATED IN THE PROPOSAL AND DOES IT EXPLAIN THE UNDERLYING BASIS FOR THE PROPOSED WORK? Yes there is a conceptual model that clearly outlines the basis for the approach and modelling. Like all conceptual models, it is a gross simplification of some very complex nested processes. I have no problem with the applicant's conceptual model, but hope that the applicants might consider to what extent their conceptual model could be wrong. CALFED has encouraged the use of transparent conceptual models to explain the basis for projects. However, there is little consideration for how applicants should intercompare competing conceptual models. What makes a conceptual model "right"?</p> <p>IS THE SELECTION OF RESEARCH, PILOT OR DEMONSTRATION PROJECT, OR A FULL-SCALE IMPLEMENTATION PROJECT JUSTIFIED? This is a full-scale implementation project and it is refreshing to see such an application put forth within CALFED. Few projects actually attempt to deliver at the system-wide scale.</p>
Rating	excellent

Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	<p>IS THE APPROACH WELL DESIGNED AND APPROPRIATE FOR MEETING THE OBJECTIVES OF THE PROJECT? The approach is well designed, but assumes quite confidently that all the components of the approach will go smoothly. With</p>
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Technical Review #2

a scope as large as the applicants are considering, it seems prudent to make considerations for the unexpected.

IS THE APPROACH FEASIBLE? The approach is ambitious but likely feasible. I have less concerns about the feasibility of the modelling as compared to the data acquisition and management. The assumption seems to be that all the data exist or (in the case of temperature) can be easily acquired. There is little consideration within the application for what to do if for example 10 percent of the temperature data loggers fail, or how to work with existing data sets that will undoubtedly be in slightly different formats to that which their models require. It reads like an ambitious plan put forth by a project manager, that some poor graduate student will be stuck figuring out how to deal with. I mention this here simply because it is important for the applicants to be realistic about the problems and inconsistencies they will inevitably face when working with this data. The applicant team has a demonstrated track record and would likely be able to resolve such issues.

The applicants have not provided any indication in this proposal as to how critical each of the individual components are to the overall goal of providing this 'complete' regional model of the Sacramento River system. For example, if the data on one of the tributaries or reservoirs proves completely useless, what is the impact of this on the model results? Does this only have a local effect on data for that tributary, or will this have a major impact on the overall predictions in the Sacramento River for example? Having raised this point, it is likely that some sort of assumptions can be made to run the model any way in such an instance and get an 'answer'. The question to the applicants, is how well you weigh or assess the quality of the results in such a situation?

ARE RESULTS LIKELY TO ADD TO THE BASE OF KNOWLEDGE?

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The applicants have astutely highlighted a major knowledge gap, with respect to temperature modelling and the impacts of climate change that has general received too little consideration by CALFED. Their results should undoubtedly add to the knowledge base information in a rather holistic way. Most CALFED funded projects are small, localized projects sold on the notion that the information and techniques will easily be upscaled to the Bay-Delta system as a whole. This project, by contrast, is designed to produce information at the system-wide scale.

IS THE PROJECT LIKELY TO GENERATE NOVEL INFORMATION, METHODOLOGY, OR APPROACHES? The project relies heavily on relatively simple, tried and true models being applied essentially through brut force to generate information at a rather impressive regional scale. This approach is not necessary novel, in that it is simply an upscaling of existing methodologies. The information produced, however, should be valuable and novel in that it provides

WILL THE INFORMATION ULTIMATELY BE USEFUL TO DECISION MAKERS? The information provided should be useful to decision makers, provided the decision makers understand what it means. The applicants have proposed setting up workshops to do just this, yet it might be naive to expect two work shops will adequately convey the complexity of these issues to decision makers. This should not be held against the applicants, it is simply a reality to be aware of. The applicants could improve this proposal and the value of the information to decision makers by more explicitly communicating the uncertainty in the information they are producing and what the ramifications of that might be. Simply reporting assumptions and accepting some implicit uncertainty is inadequate. There is also little consideration for how this information might be used adaptively or how the findings may change with increased knowledge, modified models and/or additional data.

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Rating	good
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Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success?
Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	<p>(see also feasibility comments in Approach above)</p> <p>IS THE APPROACH FULLY DOCUMENTED AND TECHNICALLY FEASIBLE? The approach is reasonably well documented (or cited) and the modelling components are technically feasible. There is little discussion of how well their chosen models will perform compared with other available models. However, the applicants do make the reasonable argument that the simplicity of 1D models chosen is essential to undertaking a project of this spatial scale. The authors are rather ambiguous on details of temporal scope, time-steps, number of simulations, amount of sensitivity testing simulations, etc. This is partially appropriate for a proposal at this stage, but also makes it difficult to assess whether or not the quantity of simulations they are proposing is realistic. This affords the applicants some flexibility in that they will presumably produce as much as turns out to be realistic.</p> <p>WHAT IS THE LIKELIHOOD OF SUCCESS? High? A better question is what is success? Success is a value-laden judgement with little scientific meaning. If success is supposed to mean the likelihood of completing the project and generally meeting objectives, then the answer is 'high.' If success is somehow related to CALFED's other ambiguous goals, I have not a</p>
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	<p>clue.</p> <p>IS THE SCALE OF THE PROJECT CONSISTENT WITH THE OBJECTIVES AND WITHIN THE GRASP OF AUTHORS? Yes, the scale of the project is completely consistent with the stated objectives. The only concern is that the authors have demonstrated few considerations for how to cope with the inevitable problems of such a large scale project. Given their past experience, it is likely they would be able to overcome such hurdles.</p>
Rating	very good

Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	<p>IF APPLICABLE, IS MONITORING APPROPRIATELY DESIGNED (PRE-POST COMPARISONS; TREATMENT-CONTROL COMPARISONS)?</p> <p>The monitoring component of this application is based on installing roughly 1000 temperature loggers throughout the Sacramento System and a few stream gages. There is little detail in the application about the monitoring design. The applicants almost assert that monitoring stream temperature is a simple, straightforward task and popping 1000 loggers in all over California should be a breeze. With the help of student labour, they are partially correct, but I would have liked at least some details on: duration of monitoring, time-step of data logger, site selection, quality control and what they will do in the inevitable instance of logger failure. Presumably there is no provision for duplication, quality control or any validation. This is one of the major weaknesses of the application. I am no questioning the need for these loggers. The applicants rightly outline the importance of the temperature data for model calibration and validation. They then fail to mention</p>
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	<p>how 8 to 36 (max) months of temperature time series will be used in the context of predictive modelling! Presumably, the applicants intend to calibrate and validate their temperature predictions over the period of their monitoring data? They then, presumably, will assume that the parameters calibrated under these short-term contemporary conditions will be appropriate for use in their long-term future scenario forecasts? Without knowing more about the details of the their models, it is impossible for me to comment on the validity of this approach. It does however raise some serious questions. I am confident that reasonable assumptions can be made and techniques used to rationalize and defend such an approach. However, the omission of this methodological information from the application makes it difficult to assess. Also, what happens to this extensive monitoring network of temperature loggers after the study period? Will they be graciously donated to respective agencies to become part of their own monitoring networks? Will they become part of UC Davis's own real-time monitoring network (REMOTE) to provide a long term data source to the public and as an educational resource? Will they just be let out to rot in the bottom of some river? Or will they be collected at the end of the study period, stored and forgotten about in some warehouse on UC Davis's campus? ARE THERE PLANS TO INTERPRET MONITORING DATA OR OTHERWISE DEVELOP INFORMATION? Yes. The monitored temperature data is explicitly to be used in the model simulations and will be made available via the internet.</p>
Rating	fair

Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	
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Technical Review #2

	<p>ARE PRODUCTS OF VALUE LIKELY FROM THE PROJECT? There is no doubt that the products from this study will be of value both to the scientific community and water managers. My concern is that the uncertainties in the models and their results are well communicated.</p> <p>ARE CONTRIBUTIONS TO LARGER DATA MANAGEMENT SYSTEMS RELEVANT AND CONSIDERED? The applicants have made plans to provide the models and data via the internet. The data management requirements are accounted for and seem reasonable.</p> <p>ARE INTERPRETIVE (OR INTERPRETABLE) OUTCOMES LIKELY FROM THE PROJECT? Yes, a wealth of interpretations and interpretable data and information are likely to be produced in this project. Hopefully, the workshops the applicants are proposing to host will a) help the applicants learn about the sorts of interpretations are necessary from practitioners and decision makers, and b) provide an opportunity to communicate these interpretations directly.</p>
Rating	very good

Additional Comments

Comments	<p>The comment that "The field measurement program is also feasible, although it is without question the largest such undertaking ever attempted (in California and most likely world-wide)" on page 15 of the application is not necessary. If the applicants wish to make such a bold point of conjecture, do some homework or provide some references to back it up. Although the claim may have some elements of truth, I fail to see how installing 1000 temperature loggers is such a noble undertaking. In fairness, the comment is probably simply trying to emphasize the value in the large-scale implementation of a temperature monitoring network. The overstated tone, simply detracts from an otherwise good application. This point would be better taken if it were to provide more than just three years</p>
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Technical Review #2

of data with this network.

Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	<p>WHAT IS THE TRACK RECORD OF AUTHORS IN TERMS OF PAST PERFORMANCE? The entire applicant team has an excellent track record and there seems no reason to question their capabilities to do the proposed work.</p> <p>IS THE PROJECT TEAM QUALIFIED TO EFFICIENTLY AND EFFECTIVELY IMPLEMENT THE PROPOSED PROJECT? Yes, the project team is more than qualified to implement the project. The applicants point out that the project team is primarily comprised of investigators stationed at UC Davis and claim that this will allow them to efficiently implement the project. DO THEY HAVE AVAILABLE THE INFRASTRUCTURE AND OTHER ASPECTS OF SUPPORT NECESSARY TO ACCOMPLISH THE PROJECT? There are not major infrastructure requirements to complete the project. Those that are required will be easily accommodated within the respective researcher's institutions, and provisions within the budget.</p>
Rating	excellent

Budget

Is the budget reasonable and adequate for the work proposed?

Comments	<p>I was surprised to see the budget was only roughly \$1 million, considering the scope of the proposal. Given the system-wide scope of the application, and the commitment to putting the products (models and data) in the public domain, this seems a very reasonable amount to spend. The applicants seem to be making efficient use of existing resources within their respective institutions and have not padded the budget</p>
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Technical Review #2

	with excessive wish-list items.
Rating	excellent

Overall

Provide a brief explanation of your summary rating.

Comments	<p>This is a strong proposal targeted at the key issue of water temperatures in the face of climate change and tackled at a system-wide (Sacramento River at least) scale. Although I have raised some concerns about some of the details of the proposal, I am confident that the applicants could address these and provide a strong piece of research at a very reasonable price. Furthermore, the outputs of this project are well suited to fostering further studies (either by others or the applicants) and being a critical decision support tool for water management operations in the state. I think the applicants need to be more upfront and realistic about uncertainties in the information and models they are providing. The uncertainties are not a sign of weakness, but instead useful information. Overall, I would recommend this proposal for funding.</p>
Rating	very good

Technical Review #3

proposal title: CALTEMP: A BASIN–SCALE MODEL FOR SIMULATING WATER TEMPERATURE, FLOW AND SCALAR TRANSPORT IN SACRAMENTO VALLEY RESERVOIRS, RIVERS, AND STREAMS

Review Form

Goals

Are the goals, objectives and hypotheses clearly stated and internally consistent? Is the idea timely and important?

Comments	The goals and objectives of this study are clearly stated and internally consistent. They are also very ambitious. The idea is timely and important as climate change will have major impacts on the hydrology and water quality of the Delta.
Rating	very good

Justification

Is the study justified relative to existing knowledge? Is a conceptual model clearly stated in the proposal and does it explain the underlying basis for the proposed work? Is the selection of research, pilot or demonstration project, or a full–scale implementation project justified?

Comments	The study is justified based on our existing knowledge of climate change. The conceptual model is clearly stated and provides the underlying basis for the proposed work. The conceptual model uses the Sacramento River system reservoirs as a upstream boundary condition. This limits the ability to include the climatic effects on snow accumulation and melt in the Sierra and these impacts on hydrology and water temperature.
Rating	good

Technical Review #3

Approach

Is the approach well designed and appropriate for meeting the objectives of the project? Is the approach feasible? Are results likely to add to the base of knowledge? Is the project likely to generate novel information, methodology, or approaches? Will the information ultimately be useful to decision makers?

Comments	The approach is well designed and appropriate, except for the use of river reservoirs as the upstream boundary condition for hydrology and water temperature. The approach does not consider the impact of climate change on the Sierra snowpack and, in turn, the impact on seasonal timing of river flows and water temperature. This may limit the usefulness to decision makers of the information produced.
Rating	good

Feasibility

Is the approach fully documented and technically feasible? What is the likelihood of success? Is the scale of the project consistent with the objectives and within the grasp of authors?

Comments	The approach is fully documented (although I could not find any mention of the simulation time step) and technically feasible. There is a good likelihood of success. I disagree with the authors' decision to use an Access database, but that is probably a matter of personal preference.
Rating	very good

Monitoring

If applicable, is monitoring appropriately designed (pre–post comparisons; treatment–control comparisons)? Are there plans to interpret monitoring data or otherwise develop information?

Comments	The plans to monitor water temperature with 1000 data loggers is ambitious, but feasible with a sufficient number of technicians. The collection of meteorologic
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	data is less thoroughly documented. Reservoir operators should not be relied upon to collect the meteorologic data.
Rating	good

Products

Are products of value likely from the project? Are contributions to larger data management systems relevant and considered? Are interpretive (or interpretable) outcomes likely from the project?

Comments	The completed CALTEMP model should be able to provide an insight into the relative thermal components of the Sacramento River system. This will contribute to the better understanding of the Delta ecosystem.
Rating	very good

Additional Comments

Comments

Capabilities

What is the track record of authors in terms of past performance? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project?

Comments	Based on the authors' CVs it appears that they are qualified to efficiently implement the proposed project. Assuming that they have access to UC Davis resources and support, they should have the necessary support to accomplish the project.
Rating	excellent

Technical Review #3

Budget

Is the budget reasonable and adequate for the work proposed?

Comments	The budget of \$1.17 million is less than I would judge to be adequate, but with the liberal use of graduate students it may be sufficient.
Rating	good

Overall

Provide a brief explanation of your summary rating.

Comments	Overall, I think that this is a worthwhile project. I am a little uncomfortable with using the reservoirs as the upstream boundary conditions, but that will certainly save costs and limit the monitoring needs. The authors appear to be very knowledgeable and I think that they have the resources to produce a successful project.
Rating	very good